Example 16. Given this information:

$V_a = 100$ V **distance between Y-plates = 0.040 m**

$V_d = 10.0$ V **length of Y-plates = 0.100 m**

a) use accelerating voltage V_a to find electron velocity in the x-direction v_x after leaving the anode.

b) since v_x is <u>constant</u> after leaving the anode, calculate the time taken for an electron to pass through the deflecting Y-plates.

c) use deflecting voltage V_d to find the force F_y on the electron between the Y-plates.

d) find the acceleration a_y of the electron between the Y-plates.

e) At this point, you have enough kinematics information to find the y-deflection d_y between the Y-plates.

f) If the accelerating voltage is now doubled, while the deflecting voltage is reduced to 3/4 of its original value, what is the new magnitude for d_y?

a) use conservation of energy: $\Delta E_p = \Delta E_k$

$$q\Delta V_a = \frac{1}{2}mv_f^2 - \cancel{\frac{1}{2}mv_i^2} \quad (v_i = 0)$$

$$(1.6\times10^{-19})(100) = \frac{1}{2}(9.11\times10^{-31})\,v_f^2$$

$$\boxed{v = 5.9\times10^{6}\ \text{m/s}} \quad (5.93\times10^{6})$$

b) speed from a) is constant in horizontal direction through deflecting plates, so

$d = v_{av}t$ where d = length of plates

$$.100 = (5.93\times10^{6})\,t$$

$$\boxed{t = 1.7\times10^{-8}\ \text{s.}} \quad (1.69\times10^{-8}\ \text{s})$$

c) $F_E = qE$ and $E = \frac{\Delta V_d}{d}$

(deflecting force)

so $F_E = q\frac{\Delta V_d}{d}$ ← distance between deflecting plates

$= \frac{(1.6\times10^{-19})(10)}{.040}$

$$\boxed{F_E = 4.0\times10^{-17}\,N}$$

d) $F_{net} = F_E = ma$

$4.0\times10^{-17} = 9.11\times10^{-31}\,a$

$$\boxed{a = 4.4\times10^{13}\,m/s^2}$$ ($4.39\times10^{13}\,m/s^2$)

e) "vertically": $v_o = 0$

$t = 1.69\times10^{-8}\,s$ (to "fall" through plates)

$a = 4.39\times10^{13}\,m/s^2$

$d = \cancel{v_o t} + \frac{1}{2}at^2$

$= \frac{1}{2}(4.39\times10^{13})(1.69\times10^{-8})^2$

$$\boxed{d = 6.3\times10^{-3}\,m}$$ (6.27×10^{-3})

f) $d \propto \Delta V_d$ and $V \propto \frac{1}{\Delta V_a}$

so $d = (6.27 \times 10^{-3}) \times .75 \times \frac{1}{2}$

$$d = 2.35 \times 10^{-3} \text{ m}$$